U.S. Department
of Transportation

Federal Aviation Administration

Memorandum

Subject: **ACTION**: Review and Concurrence, Equivalent Level of Safety Finding for Cessna New Model 680
FAA Project #TC2548WI-T

Date: April 28, 2004

Reg Ref: §§ 25.1305, 25.1549

From: Manager, Propulsion/Mechanical Systems Branch, ANM-112

Reply to Attn. of: Bob Adamson, ACE-118W

To: Manager, Wichita Aircraft Certification Office, ACE-115W

ELOS Memo #: TC2548WI-T-P-2

Background

The Model 680 Sovereign uses electronic displays for the powerplant instruments required by §§ 25.1305 (c)(2) and (c)(3). Both high pressure compressor rotor speed (N2) and engine fuel flow (Wf), and the standby engine instrument presentation of N1, N2, and ITT, are digital numeric presentations.

The digital-only displays may unacceptably limit the flight crew's ability to properly monitor and operate the engines. The primary engine displays on turbine powered transport aircraft have traditionally displayed the engine rotor speed required by FAR 25.1305(c)(3) in an analog-only or an analog and digital format. An increasing demand to conserve primary display space has led to digital-only primary displays for those rotor speeds not normally used for power setting. This situation may result in a small cluttered, low-resolution primary display.

It is generally accepted that digital-only displays are often less effective than conventional analog displays at providing the crew with: discernible indication of the parameter during a rapid transient; and quick intuitive indication of the parameters approximate level, direction and rate of change, proximity to limits and relationship to other parameters on the same engine or the same parameter on other engines. This is why FAA AC 20-88A, paragraph 4(c), states that: "digital indicators are most valuable when integrated with an analog display".

Applicable regulation(s)

Sections 25.1305 (c)(2) and (c)(3) – Powerplant Instruments and §§ 25.1549(a) through (c) – Powerplant and auxiliary power unit instruments

Regulation requiring an ELOS

Sections 25.1305 (c)(2) and (c)(3) – Powerplant Instruments and §§ 25.1549(a) through (c) – Powerplant and auxiliary power unit instruments

Description of compensating design features or alternative standards which allow the granting for the ELOS (including design changes, limitations or equipment need for equivalency)

Standby Display of N1, N2, and ITT

The Model 680 Sovereign uses electronic displays for the standby engine instruments. This display incorporates all required engine parameters for thrust control, engine starting, and monitoring. A standby engine gage, which contains N1, N2, and ITT indication, will be powered from the standby electrical bus. The standby gage indications will be digital for all three of the parameters displayed.

The Model 680 Sovereign uses the Pratt & Whitney Canada PW306C engine with a dual channel full authority digital engine control, FADEC, system. This engine requires the use of low pressure compressor rotor speed (N1), high pressure compressor rotor speed (N2), and inter-turbine temperature (ITT). The use of these parameters are for thrust control, engine starting and overspeed monitoring. The limits and usage of these parameters are defined by the PWC PW306C engine installation manual.

The digital N1, N2 rotor speed displays and ITT temperature display have white digits against a black background positioned in a central location on the instrument panel with the display for each engine adjacent to each other. The N1 and N2 rotor speed display provides digital readouts from 0 to 120% with a resolution of 0.1%. The redline limit for N1 and N2 as established by PWC is 105.0% and the ITT limit is 920 °C. The digital display for the exceeded parameter limit will flash when either N1, N2 or ITT exceed their limit value plus the display resolution limit. If more than one parameter exceeds its limit then exceeded parameters flash in unison.

Primary display of high pressure compressor rotor speed (N2)

The Model 680 Sovereign uses electronic displays for the Powerplant instrument required by §§ 25.1305 (c)(3). This display incorporates an all digital numeric presentation for high pressure compressor rotor speed (N2).

The Model 680 engine requires the use of high pressure compressor rotor speed (N2) for engine starting and overspeed monitoring. The digital N2 speed display has green digits against a black background positioned in a central location on the instrument panel with the display for each engine adjacent to each other. The limits and usage of this parameter are defined by the PWC PW306C engine installation manual. The N2 speed display provides digital readout from 0 to 120% with a resolution of 0.1%. The redline limit for N2 as established by PWC is 105.0%. The digital display changes from green to red, flashes red for five seconds , and remains red when N2 exceeds this value plus the display resolution limit.

Display of engine fuel flow (Wf)

The Model 680 Sovereign uses electronic displays for the Powerplant instrument required by §§ 25.1305(c)(2). The fuel flow is an all digital numeric presentation.

Each engine installation incorporates a Cessna installed temperature compensated fuel flow measuring device which provides the signal for the digital fuel flow display. The fuel flow digital only numeric indication is displayed on the MFD which is centrally located on the instrument panel. For engine operation, fuel flow may be used as a verification of engine control system operation by

providing indication on the initiation of fuel flow to the engine during start (prior to ITT rise), for maintenance, as well as for any requirement for supplemental fuel consumption information. The PW306C engine installation manual, and PW306C Operating Manual do not contain any maximum or minimum operating limits, restricted operating ranges, or specific usage instructions including trend requirements for fuel flow or fuel flow indication. Therefore fuel flow is a parameter where limits, trend, or rate-of-change information are not considered an important requirement.

Explanation of how design features or alternative standards provide an equivalent level of safety intended by the regulation

Standby Display of N1, N2, and ITT

The FADEC engine control system operates with independent overspeed protection, decreasing fuel flow with increasing N1 or N2 speed. For cold conditions, a maximum fuel flow function is included which will cutback fuel with increasing N1 or N2 speed to limit engine speed. These features will prevent critical engine overspeed and are considered compensating features.

The location of the engine standby gage is such that trend or rate of change information can be quickly discerned including information needed for in-flight engine restarts, and for quickly and accurately comparing engine-to-engine data. This location was shown by flight test demonstration to meet the requirements for visibility including appropriate conditions of lighting and panel vibration.

Primary display of high pressure compressor rotor speed (N2)

The FADEC engine control system operates an independent overspeed protection system, decreasing fuel flow with increasing N2 speed. For cold conditions, a maximum fuel flow function is included which will cutback fuel with increasing N2 speed to limit engine speed. These features will prevent critical engine overspeed and are considered compensating features.

The location of the N2 display for each engine is such that trend or rate of change information can be quickly discerned including information needed for in-flight engine restarts, and for quickly and accurately comparing engine-to-engine data. This location was shown by flight test demonstration to meet the requirements for visibility including appropriate conditions of lighting and panel vibration. Normal operation of the engine high pressure compressor speed is displayed by illuminated steady green digits, and no other indication.

Display of engine fuel flow (Wf)

The fuel flow digital only numeric indication is displayed on the MFD which is centrally located on the instrument panel. The display provides a green digital readout against a black background, with a range from 0 to 4,000 PPH and a resolution of 20 PPH. The indication is individually displayed for each engine, and is identified by a white “FUEL FLOW” above the displays. A white “PPH” is located between the display for each engine. Since no engine operating limit is defined or required, the digits remain green during operation. Response of the digital display system is such that fuel flow information is easily discerned for each engine during both transient and steady state operation, and with the logical display location, comparison of engine-to-engine data can be quickly compared. It has been shown by flight test demonstration to meet the requirements for visibility including appropriate conditions of lighting and panel vibration.

FAA approval and documentation of the ELOS

The FAA has approved the aforementioned Equivalent Level of Safety Finding in Issue Paper P-2. This memorandum provides standardized documentation of the ELOS that is non-proprietary and can be made available to the public. The Transport Directorate has assigned a unique ELOS Memorandum number (see front page) to facililitate archiving and retrieval of this ELOS. This ELOS Memorandum Number should be listed in the Type Certificate Data Sheet under the Certification Basis section. [E.g. Equivalent Safety Findings have been made for the following regulation: §§ 25.1305 (c)(2) and (c)(3) – Powerplant Instruments and §§ 25.1549(a) through (c) – Powerplant and auxiliary power unit instruments (documented in TAD ELOS Memo TC2548WI-T-P-2)]

/s/

Signature: Neil D. Schalekamp
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Date: April 28, 2004

ELOS Originated by Wichita ACO:	Program Manager, Tina Miller	Routing Symbol ACE-117W

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